CHIPS THE DEPARTMENT OF THE NAVY'S INFORMATION TECHNOLOGY MAGAZINE

Unmanning Unmanned Systems

By Thomas Kidd, Mikel Ryan and Antonio Siordia - April-June 2010

The growth and diversity of military unmanned aerial vehicles (UAV) in the first decade of the 21st century has been unprecedented. To say that UAVs: "continue to be the most dynamic growth sector of the world aerospace industry" understates the obvious. "An insatiable demand for UAVs is fueling massive growth within this market," said Mr. Larry Dickerson, senior unmanned systems analyst for Forecast International. "No matter how many UAVs are built, military agencies want more."

Dickerson notes that a few years ago, UAV contracts in the millions of dollars were big news; now these awards are in the billions. "In addition to procurement, research funding for UAVs could exceed $20 billion through 2018," he added.

And while UAVs may be in the spotlight, unmanned systems aren't limited to air. Unmanned ground, air and sea systems are all force multipliers. They reduce the dangers to warfighters and represent a critical evolution in how the departments of Defense and Navy deploy military technology. But are unmanned systems truly unmanned?

More often than not unmanned systems are remotely operated via a strict and bandwidth-intensive electromagnetic tether. Radio communications between the unmanned system and a control station sequester the operator from the vehicle, but do not truly remove the man from the unmanned system. Maintaining positive control over a remotely operated vehicle requires highly reliable yet complex radio links. It also limits the capabilities of the system to those actions a remote operator can control.

Technological advances will eventually enable unmanned systems to evolve beyond their current remote-control architecture, an evolution necessary if just to somewhat relieve the burden these systems tend to impose on a finite, crucial, congested and contested resource: the electromagnetic spectrum. In this article we will examine some of the challenges as we remove the man and woman from unmanned systems and consider the future of autonomous unmanned vehicles (AUV).

It is generally accepted that a fully autonomous system would have the ability to: • Gain information about the environment;
• Work for an extended period without human intervention;
• Travel from point A to point B to point C, etc., without human navigation assistance;
• Detect objects of interest such as people and vehicles;
• Avoid situations harmful to people, property, or itself(except when part of its mission); and
• Defend and repair itself without outside assistance.

An autonomous system may also be able to:
• Learn or gain new capabilities without outside assistance;
• Adjust strategies based on its surroundings; and
• Adapt to surroundings without outside assistance.

So why can unmanned systems be such spectrum gluttons? Unable to attach a 10,000-kilometer fiber optic cable, we link the unmanned system to manned support via bandwidthintensive wireless data links. Human eyes are replaced by numerous wideband streaming video channels. Instruments and gauges are monitored by operators oceans away.

Unmanned surveillance systems transferring multispectral data from infrared and ultraviolet sensors take up a staggering amount of bandwidth, as do both standard and high-speed, full motion video. Also, consider that to reach a geographically remote control station the unmanned system mission and control data must be retransmitted, usually via satellite, effectively doubling the bandwidth required. A Predator, Reaper or Global Hawk UAV, for example, can easily take up to a full transponder on a satellite to transfer data.

“The demand is huge because commanders no longer want pictures taken last week; they want streaming video with enough clarity and fidelity to anticipate the actions of the enemy,” said retired Army Maj. Gen. Robert Scales, a military historian. "Thus, we are not even within five percent of what’s really needed.”

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A Pentagon presentation in 2008 showed demand for video was more than four times the supply and increasing exponentially. Currently, tactical Predators and Reapers supply more than 400 hours of video daily. Some of these warfighter platforms have expanded to carry 10 cameras today and will mount up to 30 by 2011, adding to the profusion of video and further exhausting scarce electromagnetic assets.

Beyond the immediate issue of bandwidth and spectrum constraints, the ability to leverage the host of imagery and signals intelligence is quickly becoming unmanageable. Much of the imagery gathered during collection is either lost to information overload because humans cannot adequately process it in real time, or it serves little purpose since today's processing power and analytical algorithms are inadequate to meet either supply or demand. As data gathering exponentially increases, hiring more analysts is not a viable option.

Future development must not simply focus on greater autonomy in the unmanned vehicle. We must also recognize that both real-time and post-operation analyses are two sides of the same coin. Some type of autonomous analysis needs to take place on the vehicle if we hope to sever the constant link between platform and operator. The system could still keep a human in the loop for firing at urban ground targets. The vehicle would only need to share relevant imagery and wait for permission to fire.

The primary goal of autonomous unmanned systems must remain reducing the danger to the warfighter. But autonomous unmanned systems must have a secondary goal of increasing the efficacy of our forces as a force multiplier of intelligence, surveillance and reconnaissance (ISR) assets. And by cutting the electromagnetic umbilical cord, autonomous unmanned systems will be much more spectrum efficient.

Lastly, there will be eventual cost savings of autonomous over manned and unmanned based systems — something we must consider in a budget constrained environment. The MQ-1 Predator's role as a force multiplier usually goes unquestioned until one considers the footprint that accompanies the system.

The U.S. Air Force fact sheet notes that the typical "fully operational system consists of four aircraft (with sensors), a ground control station, a Predator Primary Satellite Link, or PPSL, along with operations and maintenance crews for deployed 24-hour operations."

For those four aircraft, this involves 55 or more personnel. And while some personnel would be needed for logistics and maintenance of any system, roughly half of that 55-person footprint is made up of flight crew. As vehicle control becomes autonomous, so too must the analysis and maintenance.

While the full realization of autonomous systems may be decades away, we need to take steps toward developing technology in this direction today. First and foremost are the mathematical, software and processing developments allowing automated systems the necessary onboard intelligence to be autonomous?

In the same way, with the likely wide dispersion of these platforms, and the need to work in concert with a host of other varied platforms, development toward secure interoperability standards for the autonomous systems is also a must. The sum of human regulation has been based on managing the actions of people or the consequences of those actions. Ultimately a person is held accountable because it is generally understood that machines cannot be responsible for their actions.

Some of these rules and regulations will require significant, if not total, overhaul to accommodate the productive coexistence of people and autonomous systems. But if the world is to progress beyond remote control and overcome the spectrum constraints limiting unmanned vehicles, we must address these larger challenges.

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TAGS: Cybersecurity, Governance, NEN, NNE, Spectrum, Telecommunications, Wireless, Workforce

Online ISSN 2154-1779; Print ISSN 1047-9988